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Jamin J.Y., Seiny Boukar L., Floret C. (éditeurs scientifiques), 2003. Savanes africaines : des espaces en mutation, des acteurs face à de nouveaux défis. Actes du colloque, mai 2002, Garoua, Cameroun. Prasac, N'Djamena, Tchad - Cirad, Montpellier, France.

The use of legume cover crops for livestock feeding in semi arid environments

Effects of *Calopogonium mucunoides* used as forage on weight maintenance of draught donkeys during the dry season

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Abstract — The dry season in semi-arid regions is a crucial period for livestock maintenance since feed resources become scarce. Animals are maintained on low quality forage residues with a need for protein supplement where the animals' productivity is to be considered. In this study, *Calopogonium mucunoides* hay was fed to donkeys during the dry season to test its palatability and nutritive value. 12 adult donkeys were allotted to 3 groups and fed different rations as follows; Group A = Corn straw + 0.5kg supplement mixture (corn bran + cotton seed cake), Group B = *C. mucunoides* hay + 0.25kg supplement mixture and Group C = *C. mucunoides* hay + 0.5kg supplement mixture. Forage, water intake, body weight and faecal DM were measured. Forage and faecal DM were analysed. There was no significant difference in intake of the three rations. There was however, a highly significant difference in digestibility, the highest being in Group B and the least in Group A. Water intake increased while intake of feed decreased with the increase in environmental temperatures in all groups. The high digestibility of *C. mucunoides* confirms the superior quality of this legume hay over other feed resources. Notwithstanding its low palatability or acceptability by other species, *C. mucunoides,* as a forage, is a high CP source for all classes of livestock and could effectively replace the need for agro-industrial protein supplements, difficult to find by the small-holder farmer.

Résumé — Utilisation de légumineuses de couverture pour l'alimentation du bétail en milieu semi-aride : effets du *Calopogonium mucunoides* sur le poids des ânes de trait en saison sèche - En régions semi-arides, la saison sèche est une période difficile pour l'entretien des animaux, du fait de la rareté des ressources alimentaires. Les animaux sont maintenus sur des résidus de fourrage de pauvre qualité, nécessitant une complémentation protéique si l'on veut assurer leur productivité. Dans cette étude, *Calopogonium mucunoides* a été distribué à des ânes de trait au repos pendant la saison sèche pour tester son appétibilité et ses valeurs nutritionnelles : 12 ânes adultes ont été repartis en 3 groupes alimentés comme suit : Groupe A = tiges de maïs + 0.5 kg d'une provende domestique constituée d'un mélange de son de maïs et de tourteau de coton en quantités égales ; Groupe B = *C. mucunoides* + 0.25 kg de provende ; Groupe C = *C. mucunoides* + 0.5 kg de provende. La consommation de fourrage, d'eau et le poids vif des animaux ont été enregistrés. Des échantillons de fourrage et de fèces ont été analysés. Les résultats n'ont montré aucune différence significative dans la consommation de fourrage. Une différence hautement significative a été observée pour la digestibilité des rations proposées, la meilleure étant pour le groupe B. Quel que soit le groupe, la consommation d'eau augmente et l'ingestion de fourrage diminue lorsque la température ambiante s'élève. La forte digestibilité de *C. mucunoides* confirme sa qualité supérieure aux autres ressources alimentaires. En dépit de sa faible appétibilité ou acceptabilité par d'autres espèces, *C. mucunoides* présente un taux élevé de protéines brutes intéressant pour tous les animaux. Elle pourrait effectivement remplacer les sources agro-industrielles de compléments protéiques, difficiles d'accès pour les petits exploitants.

Introduction

Poor nutrition is an important limiting factor in the development of livestock production in the semi-arid regions. This is evident in the seasonal fluctuation of body weight of animals within the year in response to variation in feed availability. This variation is attributed to the reduced and irregular rainfall (900-1000 mm), and the low soil fertility which also limits agriculture in this zone. Natural pastures which constitute the main source of feed for livestock change in nutrient content with the seasons. These pastures in North Cameroon, consisting mainly of annual grasses, are often low in crude protein (CP) especially at maturity. They however sustain a wide range of animals both domestic and wildlife, among which are sheep, goats, cattle and donkeys.

The donkey is considered a desert or arid zone equid, tolerant to high radiant heat, poor forage and restricted water. They have been shown to maintain themselves as adequately as goats or camels on low quality roughage (Mueller & Houpt, 1990). Their work output could however, be significantly reduced as a result of the poor feed. In 1999, the donkey population of the North and Far North Provinces of Cameroon was estimated at about 25 500 heads, 70% of which are found in the rocky areas of the cotton–producing region of Cameroon (Ebangi & Vall, 1999). Farm size per household in this region ranges from 2 – 15 hectares with very limited means for investment. Draught donkeys which are relatively cheap to obtain therefore play an important role in agricultural activities. They are especially used for transportation of products to and from farms and the market and to a lesser extent for ploughing and weeding. They constitute a major work force (about 20%) in these small-holder crop/livestock systems (Ebangi & Vall 1999). Their fitness during the dry season is crucial for a timely and effective land cultivation for the next cropping season.

In the dry season, donkeys, like other livestock, are largely maintained on crop residues which are quite low in nutrient content. Three methods have been proposed for improving the nutrient quality of feed for animals in this region. These include application of N fertiliser to the land, addition of legumes to the pastures and the feeding of industrial protein supplements to livestock (Leng, 1984). The major role of any form of supplementation is to correct the nutritional deficits of the main diet, which could be seen either in increased intake or better utilisation (Leng, 1990). Supplementation with a low cost mixture composed of cotton seed cake and corn bran has been suggested for use with draught donkeys in this region. (Vall et Abakar,1999). High levels of this supplement have been used to maintain body weight and work force of animals during this crucial period. This situation however, have sometimes led to death as some animals often get to a point where intake can no longer be increased to supply the desired energy at that point in time. Most smallholder farmers who give protein supplements to their draught animals would favour cattle as this can easily be reformed and sold as meat if seen in good condition. The donkey in reality, is most often left to fend for itself at a period where there is almost nothing left on pastures. Legume hays can therefore provide an inexpensive alternative as most legume species can maintain a CP content of more than 8% even in the dry season (Ikhimioya, & Olagunju, 1996).

Legume cover crops have been introduced in this region over the years for their soil improving and mulch production characteristics (Klein, 1995; Carsky & Ndikawa, 1998; Youri, 1998; Onana & Yonkeu, 1994). Most of these studies have been geared towards improving soil conditions for cereal and cotton production. Very little has been done on their forage use (Asongwed-Awa & Njoya, In press) even though we are in a region where livestock is an integral part of the livelihood in most households.

Calopogonium mucunoides is a trailing or twining perennial legume which regenerates freely from seeds and is well adapted to this region (Klein, 1995). It grows well in mixtures with grasses and although it is low in palatability (Rotar & Kretschmer, 1985) its CP content is quite high; ranking highest among some selected green plants available to livestock in the dry season (Table 1) (Ikhimioya & Olagunju, 1996).

This species has been introduced widely to farmers in this region for use as cover crops for soil regeneration and improvement, where DM yields of over 7 tons /hectare have been obtained (Youri, 1998 ; Klein, 1995). Apart from its use in soil protection and fertility improvement, *C. mucunoides* could also be used to improve the ration of livestock in providing the protein required for maintenance especially during the dry season.

Table I. Nutrient composition of some selected forage species available to livestock in the dry season in the semi-arid region.

	%						mg/kg			
Scientific Name	CP	Ca	Mg	P	K	Na	Mn	Fe	Cu	Zn
Eleusine indica	12,9	0,2	0,2	0,1	2,9	0,1	131	66	4	156
C. mucunoides	24,3	1,2	0,2	0,1	2,1	0,1	114	112	10	108
Vigna unguiculata	16,2	2,4	0,3	0,2	3,9	0,1	31	121	9	118
Cajanus cajan	21,1	0,8	0,2	0,2	1,5	0,1	48	133	8	42
Gliricidia sepium	20,2	2,0	0,4	0,2	3,2	0,1	61	128	5	21
Terminalia catapa	18,9	1,7	0,3	0,2	2,4	0,1	29	69	12	32
Sida acuta	17,6	2,4	0,5	0,3	3,5	0,1	91	108	5	8

Adapted from Ikhimioya & Olagunju,1996.

Objectives

The main objectives of the present study were therefore to test the palatability of *Calopogonium mucunoides* and its effect on weight maintenance in draught donkeys. More specifically, the study aimed at determining the best ration which can be used to cover the need for protein supplements in resting donkeys during the dry season.

Materials and Methods

This trial was carried out on-station at the Institute of Agricultural Research for Development (IRAD) Garoua, located in the sudano-sahelian belt (latitude 9.3 degrees North) of Cameroon, at an altitude of 400m above sea level. Ambient temperatures during the trial months (February – March) were between 30 and 40 degrees centigrade with an average annual rainfall of 980mm.

Experimental Design

Twelve adult donkeys weighing averagely 112 kg each were used for the trial. The donkeys were allotted to 3 groups in such a manner as to equilibrate the groups by weight. These groups were then randomly assigned to different treatments and fed as follows.

Group A = 0.5kg supplement mixture (cotton seed cake/corn bran) + 2.5kg of corn straw (standard diet) (Vall, et al. 1999), which served as control,

Group B = 0.25kg supplement mixture (cotton seed cake/corn bran) + 2.5kg *Calopogonium mucunoides* hay

Group C = 0.5kg supplement mixture (cotton seed cake/corn bran) + 2.5kg of *Calopogonium mucunoides* hay.

Clean drinking water was provided to individual animals in buckets in the mornings and afternoons. Corn straw was harvested after grain harvests and stacked in November, while *Calopogonium mucunoides* hay was harvested in the dry season, about 7 months after regeneration. Corn straw was chopped before serving.

Animals and Management

Animals were penned individually overnight throughout the trial. After their morning ration of concentrate and drinking water, the donkeys were released into a fenced area of about 500 m² where they freely played from about 10 a.m. to 1 p.m. During this period they had no access to pasture or any

other feed. They were closely followed up by attendants who collected faeces and identified for weighing where necessary. Pens were cleaned every morning of urine, faeces and food remains. The trial lasted for two months.

Measurements

Intake

Corn straw and *Calopogonium mucunoides* hay were weighed daily and distributed to individual animals. Leftover forage was gathered each morning and weighed to determine intake. Water intake was also measured every morning and afternoon to obtain total intake per day.

Weight

The animals were weighed at the beginning, and subsequently twice a week thereafter to obtain weight changes during the trial period.

Digestibility

In the third week, faeces were collected daily from individual animals and weighed each morning. Samples were extracted, weighed and oven dried at 65°C to a constant weight to determine DM content of faeces. At the end of the seven day collection period, the daily dried samples were mixed and a sample withdrawn and sent to the laboratory (CIRAD-EMVT, Montpellier) for analysis.

Calculations and statistical analysis

Apparent digestibility were calculated from total feed dry matter intake and faecal dry matter output over the seven days. Feed intake, digestibility and weight changes were compared using ANOVA (SAS).

Results

The nutrient composition of the different feeds offered is presented in Table II.

Table II. Nutrient composition of feeds offered.

Sample	DM	NDF	ADF	Hemi	Protein	Ash	Crude fibre
C. mucunoides offered	92,18	60,37	45,64	52,88	12,61	7,93	41,90
C. mucunoides refusal	93,07	46,72	34,71	12,01	14,73	20,29	29,79
Corn straw	90,88	61,47	37,71	31,62	3,37	5,63	42,35
Suppl. mixture	86,08	32,88	16,51	58,09	23,88	12,88	13,48

DM: Dry Matter; NDF: Neutral Detergent Fibre; ADF: Acid Detergent Fibre.

- Forage and water intakes

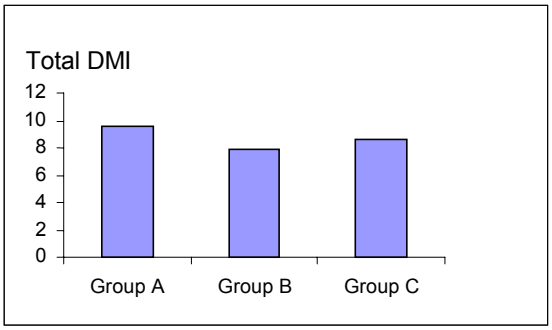

Figure 1. Total Dry Matter Intake (DMI) in the different groups.

Forage intake (Dry Matter Intake : DMI) was slightly higher in Group A (corn straw + suppl. mixture)(Figure 1) though the difference was not significant, thus indicating that the higher supplement content in diets A and B had no effect on intake (Table III).

Table III. Effect of legume basal diet on feed intake by draught donkeys.

	Ration A	Ration B	Ration C
Forage DMI kg	3,2 ± 0,2	3,1± 0,06	3,1± 0,1
Total DMI	3,5± 0,2[a]	3,3± 0,06[b]	3,4± 0,1[a b]
Total DMI/100kg	2,8± 0,15	2,8± 0,23	2,9± 0,24
Total DMI g/w0.75	92,2± 4,9	91,3± 5,2	92,3± 6,5
DDMI g/w0.75	52,3± 8,9[b]	60,2± 7,7[a]	49,5± 4,4[b]

[ab]Means with different superscripts along a row are significantly different (p<0.05).

Water intake increased and feed intake decreased in all groups with increase in temperature (figure 2).

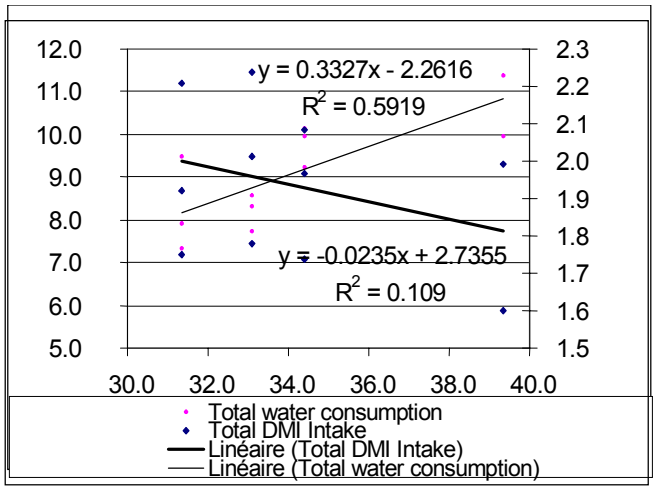

Figure 2. Effect of temperature on forage and water intake.

- Maintenance of live weight

There was a 3% increase in weight in Group C compared to 2 and 1% in Groups B and A respectively (Figure 3 and Table IV).

Table IV. Effect of legume basal diet on feed utilisation by draught donkeys.

	Ration A	Ration B	Ration C
Digestible CPI g	317± 6,0c	510± 8,1b	621±14,2a
NDFI kg/d	2,1± 0,1a	1,9± 0,04b	2,0± 0,07ab
Digestible NDFI %	1,1± 0,2	1,1± 0,2	0,9± 0,1
ADFI kg/d	1,3± 0,07b	1,5± 0,03a	1,5±0,05a
Digestible ADFI %	60± 0,1a	80± 0,1b	70± 0,09b
Live Weight gain %	1,4± 4,6	1,9± 7,6	2,8± 3,6

Means with different superscripts along a row are significantly different (p<0.05).

CPI: Crude Protein Intake; NDFI: Neutral Detergent Fibre Intake; ADFI: Acid Detergent Fibre Intake.

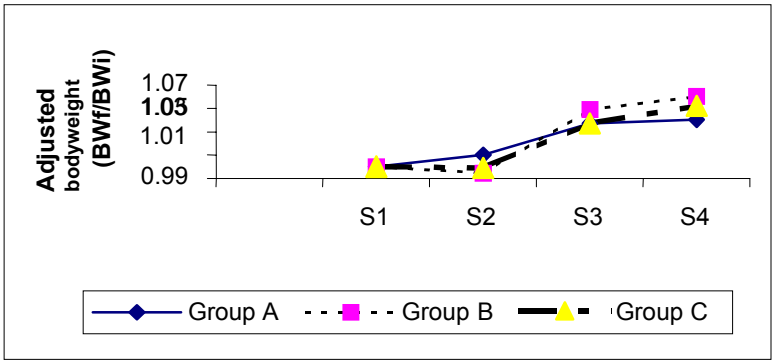

Figure 3. Liveweight changes in the 3 groups of animals.

- Determination of the best diet

The digestibility coefficients of nutrients in the basal diets are shown in Table IV. The results show low levels of crude protein and other minerals in the control Group A ration as compared to the very high levels in the *C. mucunoides* ration.

The high protein levels in the *C. mucunoides* refusals may be due to the fact that refusals were mainly fallen leaves, which of course are higher in nutrient content than the stems.

Table V. Apparent digestibility of the different rations.

Sample	DM	NDF	ADF	Hemi	Protein	Ash	Cell. brute
Ration A	.54	.32	.33	.48	.43	-	.56
Ration B	.67	.66	.68	.66	.47	-	.86
Ration C	.62	.33	.33	.35	.34	-	.54

DM: Dry Matter; NDF: Neutral Detergent Fibre; ADF: Acid Detergent Fibre.

The difference in digestibility was highly significant ($P<0.001$) for the different rations, with highest being in group B (67%) compared to 62 and 54% in Groups C and A respectively. Digestibility of other components was also highest in the Group B animals (Table V). The very high CP level of the group C ration might thus have suppressed digestibility of the other nutrients.

Discussion

These results showed no significant difference in intake of corn straw/supplement diet as compared to the pure-legume/supplement diets but rather a highly significant difference in their digestibility as well as all the nutrient components, hence better utilisation of the legume based diets.

A low intake of this species was reported in another study with lactating cows (Asongwed-Awa & Njoya, In press). This however was not quite evident with draught donkeys, thus supporting the fact that they are hardy animals, capable of sustaining very difficult conditions, hence their adaptation to arid and semi-arid zones. The slightly low intake in the *C. mucunoides* (figure 1) rations may have been due to its low palatability (Rotar & Kretschner, 1985) or acceptability (Meisner *et al.*, 2000). This has been found to limit intake of certain forage species. Palatability of C. *mucunoide* seems to improve as the forage matures (Ikhimioya & Olagunju, 1996). This may be as a result of the lose of the tiny brownish hairy nature which is characteristic of its fresh leaves, thus improving its acceptability. This stage of maturity coincides with the dry season period in semi-arid regions when grasses are all dry and of very low quality and livestock species are found in dire need of protein supplements. They would therefore select even in nature, species that would provide essential nutrients at that point in time, and legume species such as *C. mucunoides*, which survive and maintain high nutrient levels during this period are a best bet. Low

amounts of indigestible fibre, rapid fibre digestion rate and rapid turnover rate are other attributes associated with increased intake which are all related to the chemical composition and physical characteristics of the feed (Meissner *et al.*, 2000).

Studies in Zimbabwe showed that supplementation of draught oxen ration in the dry season with groundnut husks for 1-2 months produced a significant weight increase and these animals exerted more energy and ploughed larger area per day than the non-supplemented ones (Pearson & Vall, 1998). Groundnut husks, like *C. mucunoides* hay, are high in CP and other essential minerals, which are lacking in cereal straw. Other studies in Cameroon with C. *mucunoides, Stylosanthes hamata* and natural pasture grazing by lactating cows produced a significant increase in milk yield from animals grazing the legume plots for 5 hours a day (Asongwed-Awa & Njoya, In press). These affirm the superior quality of legumes over other feed resources such as corn straw and natural pastures.

Njoya, 1992, observed a 16% increase in forage intake when steers were supplemented with 0.5kg of cotton seed meal during the dry season. This however, did not improve with a higher amount (1kg) of the protein supplement but rather, digestibility was depressed. He suggested that higher amounts of protein in the diet might have caused some imbalance in the digestive tract leading to poor utilisation. This is in line with the better utilisation obtained in this trial with the Group B animals who were fed half the quantity of protein supplement as compared with Groups A and B.

Digestibility is an important factor that affects animal productivity. This is often depressed at high levels of dry matter consumption because the forage is in the rumen for a limited period of time. The higher level of digestibility in the Group B diet is an indication of better utilisation, even though the trial did not last long enough for this to be expressed in terms of weight gain. This diet which contains half the supplement mixture offered in the other two diets, turned out to be the best utilised and hence the cheapest as a result of the extra protein obtained from the *C. mucunoides*.

Conclusion

Intake of *C. mucunoides* in this trial was not as high as expected of legumes. However, the higher digestibility obtained from these *C. mucunoides* based diets is proof of a better utilisation by the animal which is therefore an indication that this species can effectively supply the protein required for maintenance. Other factors such as palatability and acceptability of the species must have played a major role. These can however, be managed for better utilisation by other livestock species. Improving productivity of pastures by the introduction of high yielding legume species is a strategy that will likely have a positive impact on animal productivity. The high nutrient content of *C. mucunoides*, and its adaptability to this region are avenues that should be exploited and used for the benefit of livestock and its productivity in the semi arid regions where feed quality and availability are major constraints to productivity.

Acknowledgement

We wish to acknowledge financial support offered by PRASAC that enabled us to carry out this trial. Special thanks to Dr. Njoya A (Chief of Station, IRAD, Garoua), and Dr. Awa D. for their help in data analysis and editing of this paper.

Bibliography

ASONGWED-AWA, A., NJOYA, A. (In press). An integrated approach to forage seed production and utilisation by lactating cows in North Cameroon. Accepted for publication in Revue d'élevage et de médecine vétérinaire des pays tropicaux.

CARSKY, J.R., NDIKAWA, R., 1998. Identification of cover crops for the semi-arid savannah zone of West Africa. In: Cover crops in West Africa; contributing to a sustainable agriculture. Ottawa, Canada, IDRC, Ibadan, Nigeria, IITA, Benin, Cotonou, Sasakawa Global 2000, p. 179-187.

EBANGI, A.L, VALL, E., 1998. Phenotypic characterisation of draught donkeys within the sudano-sahel zone of Cameroon. Revue d'elevage et de médecine vétérinaire des pays tropicaux, 51 (4) : 327-334.

IKHIMIOYA, I., OLAGUNJU, B.O., 1996. Chemical composition of selected green plants available to small ruminants in the dry season in humid Nigeria. Tropicultura : 14, (3)

KLEIN, H.D., 1995. Introduction des légumineuses dans la rotation céreale-cotonnier au Nord Cameroun: Gestion et Utilisation. CIRAD-EMVT. Maisons-Alfort, France, 179 p.

LENG, R.A., 1984. Supplementation of tropical and sub tropical pastures for ruminant production. In F. M. C. Gilchrist and R.I. Mackie (eds). Herbivore nutrition in the subtropics and tropics. The Science Press, Craighall, South Africa, p. 129-144.

LENG, R.A. 1990. Livestock feed resources and constraints to their utilisation in Tropical Developing countries. In: Preston et al, (eds). Integration of livestock with crops in response to increasing population pressure on available resources. Seminar Proceedings 11- 14 July 1989, Mauritius. CTA, Wageningen, The Netherlands, p. 31-55.

MEISSNER, H.H., ZACHARIAS, P.J.K., O'REAGAIN, P.J., 2000. Forage Quality (feed value). In: Neil Tainton (ed). Pasture management in South Africa. University of Natal Press, Pietermaritzburg. S.A. 355 p.

MENCHEN, N.R., 1979. Digestion, Absorption & Excretion in Ruminants. In: D.C. Church (ed). The Ruminant Animal; Digestion Physiology & Nutrition. Prentice Hall, Englewood Cliffs New Jersey, USA, p. 172-201.

MUELLER, P.J., HOUPT, K.A., 1991. A comparison of the responses of donkeys (*Equus asinus*) and ponies (*Equus caballus*) to 36 hours of water deprivation. In: Fielding, D & Pearson, R.A. (eds). Donkeys, Mules and Horses in tropical agricultural development. Proceedings of a colloquium organised by the Edinburgh School of Agriculture and the centre for tropical Vet. Medicine of the University of Edinburgh, Scotland, 3rd-6th September 1990, p. 86-95.

NJOYA, A., 1992. Effects of cottonseed meal supplementation on the performance and pasture utilisation by zebu steers. Ph.D. Thesis, Iowa State University, Ames, Iowa, USA, 111 p.

ONANA, J., YONKEU, S., 1994. Adaptation au milieu de quelques espèces exotiques introduites à Garoua entre 1984 et 1987. Revue Sci. Dév., 3 : 71-78.

PEARSON, R.A, VALL, E., 1998. Performances et conduite des animaux de trait en Afrique sub-saharienne : une synthèse. Revue élev. Méd. Vét. Pays trop., 51 (2) : 155-163.

ROTAR, P.P., KRETSCHMER, A.E. JR., 1985. Tropical and Subtropical forages In: Heath et al (eds.). Forages: The Science of Grassland Agriculture. Iowa State University Press, p. 154-165.

VALL, E., OUMAROU, A., 1999. Alimentation raisonnée de l'âne de trait a base de tiges de mais et de provende domestique compose de tourteau, de drêche et de son. Document de travail IRAD/PRASAC C4TA, 11 p.

YOURI, A., 1998. Système de culture avec légumineuses au Cameroun. In: cover crops in West Africa ; contributing to a sustainable agriculture. Ottawa, Canada, IDRC, Ibadan, Nigeria, IITA, p. 225-227.